

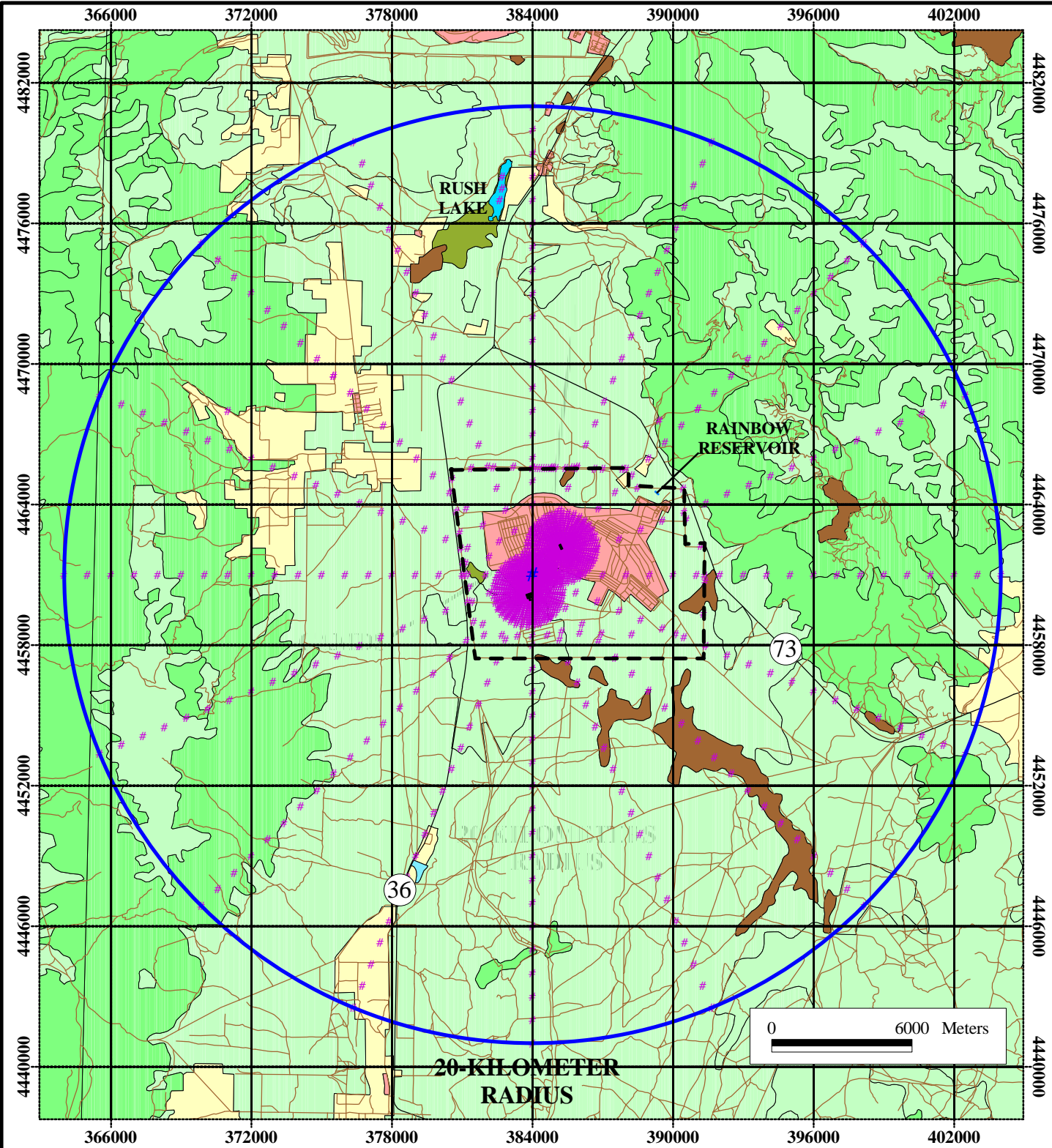
3.0 AIR DISPERSION AND DEPOSITION MODELING

Section 3.0 presents an overview of the atmospheric dispersion modeling performed at DCD in November 1999 (MRI 1999). The modeling was performed with the current version (99155) of U.S. EPA's Industrial Source Complex Short Term-3 (ISCST3) model. The modeling was adapted from the air modeling performed for the *Screening Risk Assessment* (ATK 1996). The full report, entitled *Atmospheric Modeling of Deseret Chemical Depot Final Report*, is presented in the Attachment. The report provides a detailed description of the modeling methods, including modifications in accordance with U.S. EPA (1998a), as well as a listing of the output. Section 3.1 provides a general overview of the technical approach to the air modeling. Section 3.2 summarizes the site-specific characteristics considered in the air modeling. Section 3.3 discusses the partitioning of emissions. Section 3.4 characterizes the meteorological data used in the air modeling. Section 3.5 discusses the air modeling results. Section 3.6 discusses the procedures for the dispersion modeling of mercury.

3.1 OVERVIEW OF AIR MODELING PROCEDURES

The objective of the air dispersion modeling was to provide unitized concentrations and deposition values that are required to conduct the HHRA (MRI 1999). The ISCST3 atmospheric dispersion model requires three main types of data: (1) emission source parameters, (2) receptor locations (grid nodes), and (3) meteorological information. The air modeling procedures were in accordance with U.S. EPA (1998a) guidance, as follows:

- A common receptor coordinate system was centered on a point located between the TOCDF and CAMDS facilities. The point was placed at the Universal Transverse Mercator (UTM) coordinates of 384,000 meters (m) Easting and 4,461,000 m Northing (Zone 12). The single coordinate system center was used so that the total effect of all emission sources of a specific COPC can be evaluated. In addition, two supplemental coordinate arrays with denser-spaced nodes were centered on TOCDF and CAMDS to determine on-site maximum impacts (MRI 1999). The coordinate arrays evaluated in the air dispersion modeling are presented on Figure 3-1.
- The location of each release point was referenced to the common origin. Each emission release point was modeled using stack-specific values such as exit temperature, gas velocity, and stack height, but at a unit emission rate (1 gram per second [g/s]).



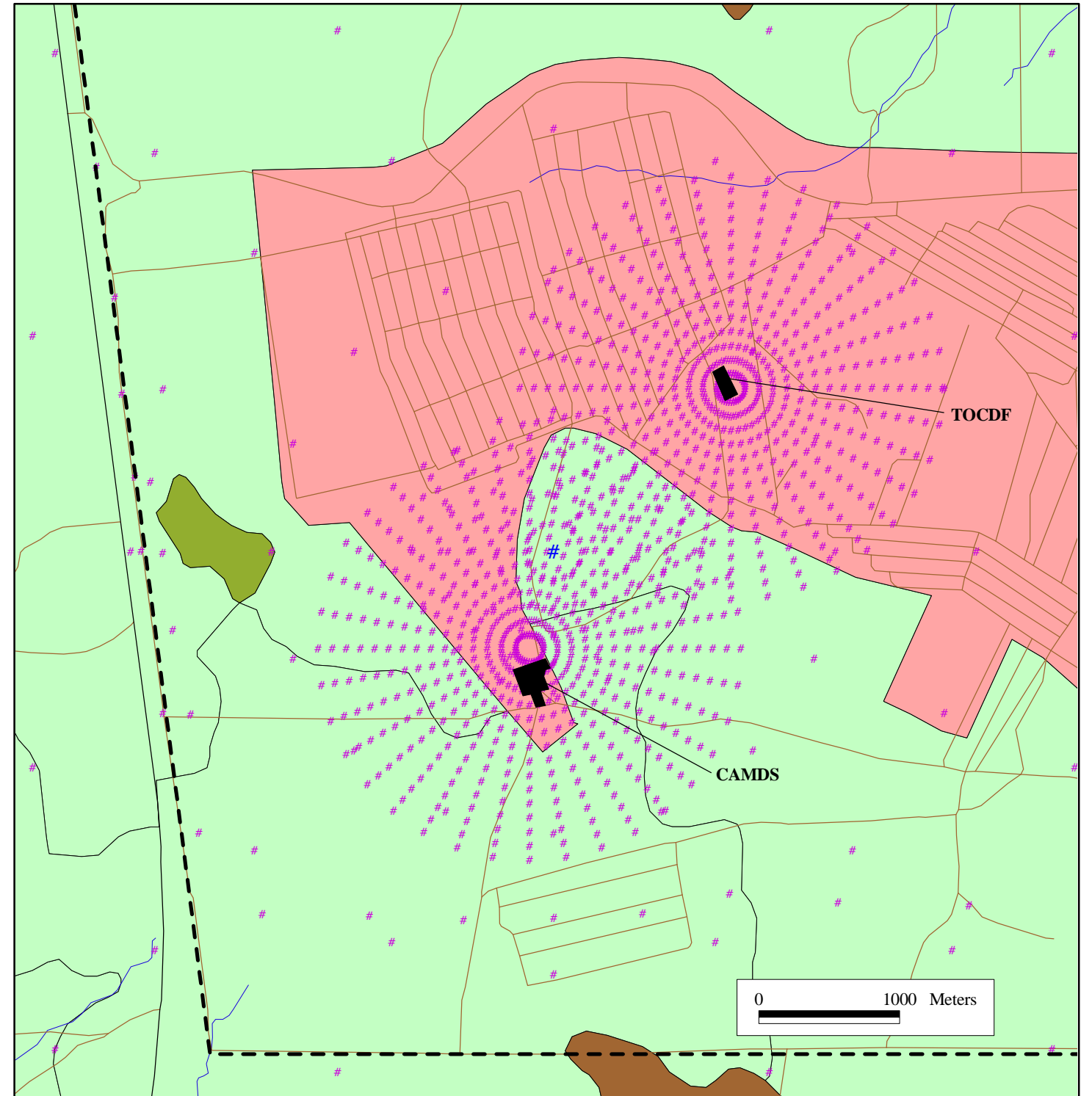
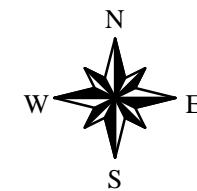
NOTES: 20-KILOMETER RADUS IS FROM A POINT CENTERED ON THE TOCDF AND CAMDS FACILITIES.
 GRID IS BASED ON THE NORTH AMERICAN DATUM 1927 1000-METER UNIVERSAL TRANSVERSE MERCATOR COORDINATE SYSTEM.
 CAMDS = CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM
 TOCDF = TOOELE CHEMICAL AGENT DISPOSAL FACILITY

SOURCES: U.S. ENVIRONMENTAL PROTECTION AGENCY, 1977, AND THE STATE OF UTAH DIVISION OF INFORMATION TECHNOLOGY SERVICES AUTOMATED GEOGRAPHIC REFERENCE CENTER, JULY 2000.

LEGEND

| LAND USE CLASSIFICATION | |
|-------------------------|------------------------|
| | AGRICULTURAL |
| | BARREN LAND |
| | FOREST LAND |
| | URBAN OR BUILT-UP LAND |
| | MIXED RANGELAND |
| | WATER |
| | WETLAND |

- DESERET CHEMICAL DEPOT BOUNDARY
- COORDINATE SYSTEM USED FOR AIR DISPERSION MODELING
- STATE HIGHWAY



UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
 DIVISION OF SOLID AND HAZARDOUS WASTE

FIGURE 3-1
 LAND USE AND LAND COVER MAP



TETRA TECH EM INC.

- Two initial screening runs showed that the off-site maximum concentrations occurred along the DCD property boundary. For this reason, discrete receptors along the property line were evaluated during the refined screening runs.
- A polar coordinate system extending a radius of 20 kilometers (km) from the center point was employed to determine “normalized” deposition rates or concentration values at each receptor grid node. The coordinate system was set up with 10-degree intervals. Both initial screening runs and refined modeling runs were performed. In addition, two refined receptor grids were evaluated for DCD and three extra grid nodes were placed at Rush Lake. The land use and land cover map (Figure 3-1) shows the coordinate systems used in the air dispersion modeling.
- For each source modeled, a separate output file was generated that contains the “normalized” deposition rate or concentration values at each grid node location, for each individual source.
- The above process was repeated (omitting the screening runs) three times to determine vapor phase emissions, particle phase emissions, and particle-bound emissions.

To determine COPC-specific concentration values and deposition rate values, the normalized concentration values and deposition rate values were multiplied by the COPC-specific mass emission rates calculated in Section 2.0.

3.2 SITE-SPECIFIC CHARACTERISTICS

The following sections discuss the site-specific characteristics used in the atmospheric dispersion modeling for DCD. Section 3.2.1 summarizes how each of the combustion units was handled in the air modeling. Section 3.2.2 presents how building wake effects were evaluated. Section 3.2.3 describes how watersheds were identified and evaluated in the air modeling.

3.2.1 Combustion Unit Emission Characteristics

A total of 10 emission sources were evaluated in the atmospheric dispersion modeling for emissions from the combustion units at TOCDF and CAMDS facilities (MRI 1999). Table 3-1 presents the sources that were considered at each of the facilities and the source-specific parameters used in the modeling, including location (UTM coordinates), base elevation, stack height, stack gas temperature, stack gas velocity, and stack diameter. Each source was modeled individually by referencing the geographical location of each source to the common coordinate system centered at 384,000 m Easting and 4,461,000

TABLE 3-1

AIR MODELING SOURCES AND SOURCE-SPECIFIC PARAMETERS USED IN AIR DISPERSION MODELING

| | UTM Easting | UTM Northing ^a | Base Elevation (m) | Stack Height (m) | Gas Temperature (K) | Gas Velocity (m/s) | Stack Diameter (m) |
|--------------|-------------|---------------------------|--------------------|------------------|---------------------|--------------------|--------------------|
| TOCDF | | | | | | | |
| DFS | 385,278 | 4,462,170 | 1576 | 30.5 | 387 | 6.81 | 1.5 |
| LIC | 385,278 | 4,462,170 | 1576 | 30.5 | 396 | 3.23 | 1.5 |
| MPF | 385,278 | 4,462,170 | 1576 | 30.5 | 384 | 3.68 | 1.5 |
| BRA | 385,337 | 4,462,031 | 1576 | 19.8 | 398 | 13.1 | 1.4 |
| HVAC | 385,234 | 4,462,266 | 1576 | 36.6 | 296 | 12.3 | 2.2 |
| CAMDS | | | | | | | |
| HVAC | 383,860 | 4,460,337 | 1536 | 5.82 | 300 | 30.8 | 0.56 |
| DFS | 383,858 | 4,460,307 | 1536 | 20.7 | 379 | 19.9 | 0.61 |
| MPF | 383,847 | 4,460,248 | 1536 | 19.0 | 388 | 10.7 | 0.61 |
| BRA | 383,767 | 4,460,336 | 1536 | 13.7 | 339 | 7.0 | 0.61 |

Notes:

| | |
|-------|---|
| CAMDS | Chemical Agent Munitions Disposal System |
| BRA | Brine reduction area |
| DFS | Deactivation furnace system |
| K | Kelvin |
| LIC | Liquid incinerator |
| m | Meter |
| m/s | Meter per second |
| MPF | Metal parts furnace |
| HVAC | Heating, ventilation, and air conditioning system |
| TOCDF | Tooele Chemical Agent Disposal Facility |
| UTM | Universal Transverse Mercator |

^a Only 6-digit UTM coordinates are allowed in ISCST3 model. Last 6 digits used in air dispersion modeling.

Northring (the center point between TOCDF and CAMDS). For modeling the sources at TOCDF that exhaust through a common stack, it was assumed that only one unit is operating at a time (MRI 1999). By modeling the sources separately, the HHRA will allow for evaluation of (1) individual risk attributed to each emission source, (2) risk from all units operating concurrently, and (3) risk from all possible combinations of emission sources. This approach will provide DSHW with the ability to meet risk management obligations as the permitting authority by allowing for the consideration of individual emission source impacts as well as provide a conservative estimate of risk from all RCRA emission sources. The limitations of modeling the dispersion of emissions from each source separately (since multiple sources may vent to the common stack at the same time) will be discussed in the uncertainty section of the HHRA (see Section 9.0).

3.2.2 Building Wake Effects

The ISCST3 model also accounts for building wake effects on dispersed plumes (MRI 1999). The model requires specific inputs, including direction-specific building heights and widths that account for elevation views of buildings under various wind directions. The data on building dimensions and locations were provided by DSHW, supplemented by additional information collected during an April 1998 site visit to the TOCDF and CAMDS facilities. The building heights and lateral dimensions are summarized in Table 8 of MRI's report (see the Attachment).

3.2.3 Watersheds

Water bodies and watersheds are important factors for evaluating exposure through the ingestion of fish, ingestion of drinking water, and incidental ingestion of surface water (discussed in Section 4.2.2). MRI used a subset of the refined modeling grid to characterize the watershed of Rush Lake, which is fed by Soldier Creek, the source of drinking water for the town of Stockton (MRI 1999). In addition, two other water bodies will be evaluated in the HHRA using existing air modeling results. Rainbow Reservoir, which is on the DCD facility, may be stocked with fish and opened by the Army to the public. SunTen Inc. operates a water ski pond about 26 kilometers west of DCD outside the township of Rush Valley.

3.3 PARTITIONING OF EMISSIONS

In accordance with U.S. EPA (1998a) guidance, the emissions were partitioned as (1) vapor phase, (2) particle phase, and (3) particle-bound emissions (MRI 1999). The ISCST3 model calculates air concentrations and wet, dry, or combined deposition values. The model also includes the effects of plume depletion by both wet and dry mechanisms.

3.4 METEOROLOGICAL DATA

Meteorological data collected from 1986 through 1990 at the Salt Lake City International Airport (SLC) were used in the atmospheric dispersion modeling (MRI 1999). The data were obtained from two sources:

- National Climatic Data Center (NCDC) Solar and Meteorological Surface Observation Network (SAMSON) 1961-1990 CD-ROM for SLC (Station 24127)
- Upper air data (mixing height) obtained from EPA's Support Center for Regulatory Air Models (SCRAM) bulletin board for SLC

The data were selected by comparing SLC data to the on-site meteorological data collected within 1 mile of TOCDF. Because of a slight mismatch in wind direction, the SLC data were rotated 10 degrees counterclockwise. MRI used U.S. EPA's program, PCRAMMET (the personal computer version of the meteorological preprocessor for the old RAM program) to determine all hourly observations. Due to a lack of site-specific data, MRI also developed default data based on information obtained from the PCRAMMET user's guide as input parameters.

3.5 AIR MODELING RESULTS

The air modeling results, which are presented in the Attachment, indicated that the off-site maximum air concentrations and depositions occurred along the north property line. Section 6 of the air dispersion modeling report describes how the air modeling results are organized and identified in a series of spreadsheet files (MRI 1999). The output files are also presented in the Attachment. The output files are not, however, compatible with the IRAP-*h* VIEW[®] software that will be used to perform the risk characterization of the combustion units at TOCDF and CAMDS. Therefore, the atmospheric dispersion modeling was re-run specifying the electronic output files required for the IRAP-*h* VIEW[®] software. The

electronic output files were identical to the hard copy output files presented in the atmospheric dispersion modeling report (MRI 1999).

3.6 MODELING OF MERCURY

U.S. EPA recommends that mercury be evaluated as a COPC in a combustion HHRA (U.S. EPA 1998a). Air emissions containing mercury contribute to local, regional, and global deposition. The U.S. Congress explicitly found this to be the case and required U.S. EPA to prioritize maximum achievable control technology (MACT) controls for mercury (U.S. Congress 1989).

National anthropogenic mercury releases are predominated by industrial processes and combustion sources that release mercury into the atmosphere (U.S. EPA 1997a). Stack emissions containing mercury include both vapor and particulate forms. Vapor mercury emissions are thought to include both elemental (Hg^0) and oxidized (e.g., Hg^{+2}) chemical species, while particulate mercury emissions are thought to be composed primarily of oxidized compounds due to the relatively high vapor pressure of elemental mercury (U.S. EPA 1997a). While coal combustion is responsible for more than half of all mercury emissions in U.S. anthropogenic sources, the fraction of coal combustion emissions in an oxidized form is thought to be less than that from waste incineration and combustion (U.S. EPA 1997a).

Analytical methods for the mercury speciation of exit vapors and emission plumes are being refined, and there is still controversy on this issue. Chemical reactions occurring in the emission plume are also possible. The speciation of mercury emissions is thought to depend on the fuel used, flue gas cleaning, and operating temperatures. The exit stream is thought to range from almost all divalent mercury to nearly all elemental mercury; true speciation of mercury emissions from the various source types is still uncertain and thought to vary, not only among source types, but also for individual plants as feed stock and operating conditions change (U.S. EPA 1997a). Most of the total mercury emitted at the stack outlet is found in the vapor phase, although exit streams containing soot or particulate can bind up some fraction of the mercury (U.S. EPA 1997a). Total mercury exiting the stack is assumed to consist of elemental and divalent species, with no emissions of methyl mercury assumed. The divalent fraction is split between vapor and particle-bound phases. Most divalent mercury is thought to be mercuric chloride (HgCl_2); this is particularly the case for the combustion of wastes containing chlorine (U.S. EPA 1997a).

Data on mercury speciation in emissions exiting the stack is very limited. The behavior of mercury emissions close to the point of release has not been extensively studied. This results in a significant degree of uncertainty in the modeling of mercury emissions. Additional examples of uncertainties include the precision of measurement techniques, estimates of pollution control efficiency, and limited data specific to source class and activity level. Discussions of uncertainty and sensitivity analyses when modeling mercury emissions are presented in the *Mercury Study Report to Congress* (U.S. EPA 1997a).

3.6.1 Phase Allocation and Speciation of Mercury Exiting the Stack

As discussed above, mercury stack emissions are thought to include both vapor and particle-bound forms, and are speciated as both divalent and elemental mercury. Based on a review of mercury emissions data presented for combustion sources, estimates for the percentage of vapor and particle-bound mercury emissions range widely from 20 to 80 percent (U.S. EPA 1997a). Therefore, EPA recommends a conservative approach, which assumes that 80 percent of the total mercury is in the vapor phase and 20 percent of the total mercury is in the particle bound phase. This allocation is:

- Consistent with historical mercury emissions speciation data for hazardous waste combustion sources
- Reasonably conservative, since it results in the highest percentage of total mercury being deposited in proximity to the source, and is therefore indicative of the maximum indirect risk.

Mercury exits the stack in both the elemental and divalent vapor forms. Based on U.S. EPA (1997a), most mercury that exits the stack does not readily deposit, but is transported outside of the U.S. or vertically diffused to the free atmosphere. The divalent form emitted, either in the vapor phase or particle bound, is thought to be subject to much faster atmospheric removal than elemental mercury. In addition, vapor phase divalent mercury is thought to be more rapidly and effectively removed from the atmosphere by both dry and wet deposition than particle bound divalent mercury, based on the reactivity and water solubility of vapor divalent mercury.

3.6.2 Vapor Phase Mercury

U.S. EPA (1998a) states that of the 80 percent total mercury found in the vapor phase, 20 percent is in the elemental form and 60 percent is in the divalent form. About 99 percent of the vapor phase elemental

mercury is transported outside of the U.S. or vertically diffused to the free atmosphere (U.S. EPA 1997a). Only a small fraction (assumed to be one percent) of vapor phase elemental mercury is either adsorbed to particulates in the air and deposited or converted to the divalent form to be deposited (assumed to be deposited as elemental mercury). Of the 60 percent vapor phase divalent mercury, about 68 percent is deposited and about 32 percent is transported outside of the U.S. or vertically diffused to the free atmosphere to become part of the global cycle (U.S. EPA 1997a).

3.6.3 Particle-Bound Mercury

Of the 20 percent of the total mercury that is particle bound, 99 percent (assumed to be 100 percent) is in the divalent form. U.S. EPA (1997a) indicates that only 36 percent of the particle-bound divalent mercury is deposited, and the rest is either transported outside of the U.S. or is vertically diffused to the free atmosphere to become part of the global cycle.

3.6.4 Deposition and Modeling of Mercury

It is assumed that the mercury deposited to media in the assessment area is entirely divalent mercury in either the vapor or particle bound form (U.S. EPA 1997a). Without consideration of the global cycle, mercury speciations will result in 80 percent of the total mercury emitted being deposited as divalent mercury and the remaining 20 percent being deposited as elemental mercury.